House Drainage

with special reference to the

Intercepting (Disconnecting) Trap.

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with discussion.

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HOUSE DRAINAGE WITH SPECIAL REFERENCE TO THE INTERCEPTING (DISCONNECTING) TRAP.

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A paper read at a Sessional Meeting of the Institution of Sanitary Engineers on 3rd December, 1924.

Introductory Observations.

The subject I have selected for discussion is an old one and has been before the scientific public for many years, but from some views which have lately been expressed, it appeared to me that it was not fully understood by some in all its bearings, and I venture, therefore, to introduce it again. No apology for this is needed, as the subject is a very important one from a health point of view.

The present English house drainage practice dates from about the year 1875 and we are indebted to those men who recognised the then urgent need of a sanitary system of house drainage and elaborated it. Amongst them I would mention Mr. Rogers Field, Sir Douglas Galton, Professor Corfield, Mr. Ernest Turner, and Mr. H. H. Collins. They have created the present system, which has worked exceedingly well and has been a model to all other countries. This system is still first and foremost and is surpassed by no other system in any other country. As I was not concerned in its creation I can speak all the more impartially about it. I would only add that both theoretically and practically, I have been engaged in the practice of house drainage for many years, it being one of my professional subjects.

I would at the outset point out that the name "intercepting trap" is misleading, as the aim of the trap is not to intercept solid matter, but to form an aerial disconnection between the house drain and the street sewer, and for this reason I prefer the name "disconnecting trap" and will use it in this paper.

I shall strictly limit my remarks to the English house drainage practice and shall only occasionally refer to the house drainage systems of other countries, but even with this limitation I shall not have time to deal with house drainage details and must confine my remarks to its chief features, as I should like to consider the subject in all its bearings, i.e., comprehensively and not sectionally.

General Considerations.

Before dealing with my subject proper I should like to make a few general remarks on sanitary engineering, as house drainage forms a branch of it.

In my opinion sanitary engineering is the science of applying the known laws of Nature to the construction of works primarily for the benefit of the health of man and secondarily for his convenience and comfort. It is a branch of the large collective science of preventive medicine as it comes to be understood to-day, and in this connection I would refer to Sir George Newman's excellent memorandum on Preventive Medicine.* In this the sanitary engineer has a large number of scientific co-workers such as the physiologist, the physician, the surgeon, the botanist, the geologist (mineralogist), the chemist, the biologist (micro-biologist), the physicist, etc., etc., with all their numerous subdivisions ; but unfortunately most of these work, as it were, in watertight compartments and the want of, what I will call in place of a better name, liaison-officers (cohesion workers), makes itself felt in many directions.

Preventive medicine has called forth sanitary engineering and if this is taken out of this frame and treated by itself, i.e., sectionally, erroneous conclusions may easily be formed.

The chief aim of sanitary engineering is to prevent disease, that is its *raison d' être,* and if it does not do that, it is a lamentable failure. But in order to succeed in this respect sanitary engineering must create such conditions of life as will maintain always at their best the natural defensive or resisting powers of the constitution, whatever they may be, so that when disease attacks it, no matter what the disease is, infectious or non-infectious, according to our present notions, it may be able to hold its own, defeat the enemy and emerge victoriously. And none of us know when he may meet hostile germs, or be subjected to the subtle influences of the beginnings of disease ! To enable the constitution to resist the beginnings of disease, to prevent in fact, all disease predisposing influences is, therefore, the prime function of the sanitary engineer, and he should never construct his works in such a manner that especially in our present state of very limited knowledge is liable to the least suspicion in this respect.

One word about the relation of host and parasite, the term host indicating the human or animal body in which the parasite has established itself and carries on its destructive work. It has appeared to me, that since Robert Koch established the means of isolating and identifying specific germs about the year 1880, the flood of bacterial research, which it brought about, has called more attention to the parasite, to the apparent neglect of the host. This has given the impression that the parasite is more important than the host, but I cannot help thinking that this is a mistake and that if the two are not of equal weight the host is probably the more important of the two. To prevent the parasite entering the host or to render the host more or less immune to the attacks of the parasite is surely wiser than to try to attack the parasite after it has established itself. The latter has been compared to a frontal attack against an

* "An Outline of the Practice of Preventive Medicine." Published by His Majesty's Stationery Office, 1919. Price 6d.

enemy of unknown strength, and frontal attacks are in the majority of cases very expensive and their result very doubtful. The better strategy seems to be to protect the host against these attacks. Prevention is always better than cure, if permanent cure is at all possible after vitality has been seriously impaired.

The field of a sanitary engineer is a very large one ; it comprises the water supply of towns and houses, the sewerage of towns and the drainage of houses, the purification of sewage, the heating and ventilation of buildings, the removal, disposal or destruction of all house refuse, the prevention of smoke or any other nuisance injurious to health, etc., etc., and those who wish to study the general progress made in sanitation during the last fifty years cannot do better than to carefully peruse the excellent résumé prepared by our veteran sanitary engineer, Mr. H. Percy Boulnois, for the very successful International Conference on Sanitary Engineering convened by this Institution in July last.

In designing his works the sanitary engineer must bear in mind a good many maxims of general engineering practice amongst which I will only mention the following. The weakest link in a chain must be fully strong enough to withstand all the strain that may be put upon it in every day's work, and if it is not dimensioned accordingly the whole structure is bound to collapse, no matter how strong all the other links are. For this purpose it is necessary to adopt carefully selected factors of safety, i.e., to make the construction several times stronger than the actually calculated strength, as in working conditions contingencies may and will arise, which cannot be calculated, and over which the engineer has absolutely no control whatever. If failure occurs through the neglect of factors of safety, the engineer will be blamed. In all health matters the factors of safety must be ample, so as to protect the health of the individual and the community as far as this is possible to do. If, for instance, in house drainage the chief, i.e., the disconnecting trap is omitted and sole reliance placed upon the secondary or minor traps in the interior of the house, the factor of safety is very seriously reduced at the risk of injury to health without the least advantage being derived from such a procedure.

Some Historical Remarks.

It will not be out of place to make a few observations on the early house drainage, i.e., the house drainage before about 1875.

That filth and disease are closely associated may be said to underlie the Mosaic law and has been clearly demonstrated by the epidemics of the Middle Ages (Plague, Black Death, etc.), but it took a very long time to drive this lesson home and even up to the middle of last century sanitary conditions were deplorable. Towns were then only very imperfectly sewered, and house drainage, so far as it existed, was most crude, cesspools and privy middens being the order of the day.

With the systematic introduction of water supply and town drainage

things began to get better, but the sanitary conditions of town and houses was still very unsatisfactory. There was no proper scheme of house drainage and everybody did what he liked.

House drains were too large, of improper material, improper shape and badly laid in many cases under the houses and without sufficient fall; they were certainly not self-cleansing and acted in many cases as deposit and storage for the waste organic matters.

The interior pipes were likewise very defective. They were laid anywhere, under floors, covered in walls, and not accessible. Material, diameter and construction was bad and they were in direct connection with the house drains and street sewers.

The sanitary fittings were likewise of the most primitive kind and gave rise to foul smells throughout the house.

I cannot speak from actual experience of these conditions, but I have repeatedly met cases which corroborate this view, and I remember seeing the "insanitary house" at the Health Exhibition of 1884, which fully exhibited the deplorable condition of things.

It was at this time that the "theory" was expressed that typhoid fever was the result of a putrid process and caused directly by foul smells from drains and sewers, as various observers had noticed that it frequently broke out in houses, the air of which had been rendered impure in this way. In this theory, which was called the "pythogenic theory," it was endeavoured to establish the self-produced or spontaneous generation of typhoid fever, and amongst its chief supporters were men such as Murchison and Riecke.

It was not long however, before men like Budd and others assailed it. Whilst admitting the facts observed by Murchison, Budd maintained that the disease was not spontaneously generated, but that putrid substances were only capable of producing typhoid fever in the presence of a specific contagion.

This controversy was taken up in Germany, where the opponents of the water carriage system of excreta utilised Murchison's theory against this system and tried to condemn it altogether. The view was then expressed (1882) by a leading sanitarian that sewer gas has no epidemiological importance and that its influence upon health must be considered from the point of general hygiene; but that the keeping of sewer gas out of our houses was an important task. According to the German views the gases contained in sewers form at a certain concentration a most poisonous combination and numerous fits observed amongst sewer men lead one to suppose that it is a question of the noxious influence produced by ammonia and sulphuretted hydrogen. The prolonged action of these gases gives rise to a chronic poisoning, which is accompanied by disturbances of the organs of digestion and nutrition, and in the end leads to attenuation and physical and intellectual weakness. When the air is very impure and saturated with ammoniacal vapours, it obstructs breathing and violently irritates the mucous membranes of the eyes and nostrils.

It was only natural that the complaints about noxious smells from street sewers and house drains led to a strong agitation, which eventually, about the year 1875, brought about the modern system of house drainage, and this in its turn led to greatly improved sanitary conditions.

From this period dates Disraeli's well-known aphorism : "*Sanitas sanitatum omnium sanitas.*"

The present house drainage practice in England.

I have already pointed out that our present system of house drainage was evolved out of previous failures—long continued—with their lamentable loss of life, but before entering on its leading features, it may not be out of place to draw attention to the conditions existing in street sewers as distinguished from those existing in house drains.

In street sewers you can never avoid foul gases or smells, especially in large towns with their miles upon miles of underground pipes, culverts and covered in brick channels of large and various diameters, even if they have been designed and constructed in the best modern manner.

I will cite the following case in point. In a large town, where we had been asked to examine an extensive new storm water scheme, we were assembled in a large dome-shaped chamber near the outfall, which had been suitably decorated and in which a tempting repast with all sorts of delicacies had been provided for us. I was just on the point of sitting down to a well-earned refreshment, when suddenly and without any warning there travelled down from the town such an abominable stench that the chamber was instantly cleared and the tempting dainties forgotten. This storm outfall had never been used for storm water, it was absolutely in a virgin condition and the nearest connection with the foul sewers of the town was about two miles above the chamber.

Again, I once took an American lady—on an inspection day—into one of the main sewers of Paris, which has become famous in history by the bloody massacre of the Communists in the Madeleine in 1871, and we had barely sat down in the boat when a stench travelled up and my friend fainted away. I also remember encountering some enormous rats in one of the branch sewers of Paris, which fortunately I was able to dispatch before they could do any harm. In the catacombs of Paris the air did not affect us at all.

A large underground network of sewers must be looked upon as a vast chemical retort, in which many opportunities exist—through interaction—for the formation of new combinations, so that no guarantee can be given that sewage at one time or other may not produce in a startling manner poisonous or other injurious effects.

In a house drainage system these conditions do not exist. Its length is much shorter, and provided it is properly designed, constructed and maintained—all very reasonable conditions—it can and as a rule is kept perfectly sweet without any occasion for the rise of poisonous gases or other injurious combinations. Apart from this the sojourn of the sewage

in the house drain is of such short duration, that there is no time for the formation of dangerous combinations.

My long experience fully bears this out and when occasionally I have come across a foul house drain this condition was due to faulty construction and neglect.

It has been stated that the air in house drains is as foul as that in street sewers, but my experience is against such a statement, and I cannot agree with it. At any rate there would appear to be no reason or cause for it except local neglect.

I have not time to deal with the details of house drainage, and those who wish to have some information about it I would refer to a paper which I read abroad in 1894, at the request of the German Association of Public Health.

I have only time to deal with leading features and principles. The principle underlying our modern system of drainage is the speedy removal of all organic waste matters out of the interior of our houses, the accessibility of all its parts and the prevention—by aerial disconnection—of the escape of foul air out of sewers and drains into them. These principles are based upon sound scientific knowledge and not on fads, as it has been recently maintained.

It has been pointed out against the position of pipes outside the buildings, that this would render them subject to the influence of frost in very cold weather.

I have always contended that if there is nothing in the pipes that can freeze, nothing will freeze, as the discharge is of too short a duration. From a good water-closet flushing cistern the discharge will not last more than from five to seven seconds. Where, however, the pipes are dirty and contain deposits this may lead to trouble outside the building in very severe weather. Again, if water-taps are slightly turned on, or if they are leaking during frosty weather, the water slowly creeping down the pipes would cause them to freeze up. It is illogical, however, to prevent the supply pipes freezing up by causing the waste pipes to freeze.

I was once met by an indignant engineer from a town near Vienna that he could not possibly adopt outside soil pipes in his place and when I pressed him for information concerning the character of his pipes, he admitted that they were made of rough sawn wood, square in section and nearly coated up with deposit. Later on I examined one of these pipes inside the building and the smell was over powerful.

I made some observations on soil pipes and other outside pipes during the severe winter—January and February—1895, when house service water pipes in the ground three feet deep were frozen in many parts of the country, and when on the 8th February the temperature fell to −20° C. in my neighbourhood, the average maximum temperature for four weeks from the 26th January to the 19th February being 0.94° C. and the average minimum −11° C. In my own house with old-fashioned plumbing installations I experienced no difficulty whatever and practically the same information I obtained from twenty-nine towns

in England, Scotland and Ireland, with a total population of about eight millions. Only in a very few cases had the frost affected soil pipes. To fully satisfy myself on this point I had cut out the lead trap and part of the lead soil pipe in my own house, when I found both perfectly free from deposit and smell.

It is an undoubted advantage to have outside pipes and nobody knowing anything about the matter can possibly recommend a return to the old system of interior pipes, except where this is absolutely unavoidable.

I attach the greatest importance to good installations, properly designed, constructed and maintained, as without these quite reasonable conditions being fulfilled no house drainage system, however perfect at first, and indeed no apparatus of any kind invented and made by man, can go on for ever giving satisfactory results, however improper its use may be. Every engine—high speed express locomotive or motor car—and indeed every utensil that is used in the house requires constant examination and cleaning. Who would advocate eating his food day in and out from the same plate without cleaning ?

Any trap used forms an obstruction to the free flow of water at any rate to some extent, and I am, therefore, not in favour of deep traps except under very special conditions. Where necessary every trap should be properly ventilated to prevent syphonage. I have dealt with these matters in my paper on the "Passage of excreta through house drains," which I read in 1909 before the Sanitary Institute, and to which I may be allowed to refer at this point. I would only mention that the following depths of water seal and water contents are as a rule quite sufficient :

3½in. water closet trap, 2 in. seal, 2 to 4 pints maximum, 6 pints.
4 in. disconnecting trap, 2½ in. seal, not more than 5 pints.
6 in. ,, ,, 2½ in. ,, ,, ,, ,, 9 pints.

I particularly object to bends in soil pipes and I have counted as many as ten in the ventilating end of soil pipes. Some plumbers seem to have a mania for them. Each bend, especially a sharp one, acts as an obstruction to the free flow of air and in cast-iron soil pipes as a collecting place for rust and dirt, practically blocking all air movements. I remember a case of an iron soil pipe with four bends, where I could not get smoke through, however much I increased the pressure, when suddenly a small explosion with a good deal of noise occurred and the smoke was driven out at the bottom. The top of each ventilating pipe must be properly protected.

In health matters as indeed in many other engineering constructions, the most efficient work is almost bound to be the cheapest in the long run.

Present views as to the injurious character of sewer air.

Before proceeding to deal with our present views as to the injurious character of sewer air upon health with a view to understanding this subject more fully I will make a few observations as to our present means of investigating matters of this kind.

Unfortunately it is a fact that our present means of investigation are still very incomplete and that any analysis—chemical, bio-chemical, bacteriological, etc.—only reveals a portion of the contents of the sample analysed and not the whole. To this must be added the difference in the skill, experience, outfit, etc., of the different observers, so that it cannot be surprising when now and then almost opposite views are expressed by different investigators.

I do not wish in the least to belittle the results of present day observations, I merely wish to point out what is a fact, that all investigations must be treated with considerable reservations and that it would be wrong to attach equal weight to all of them.

In the present state of our knowledge it is impossible to assign for every specific effect its specific cause, and until we are in this position, we must remember our limitations.

In this connection I would point out that it has been shown that the sense of smell in man is at least a million times more delicate than the most refined of physical tests, such as the spectroscope, and probably a thousand million times more delicate than the most refined tests of bacteriology.

Nature has always been reluctant to part with her secrets and I believe Darwin has stated in his "Origin of Species" that she would tell you a lie, if possible. An experiment is a question addressed to Nature, and if it is addressed in an incomplete or wrong way, the answer is bound to be incomplete or wrong.

The progress made up to now in elucidating Nature's laws has shown that it is a very slow one. Take only the decomposition of dead organic matter. Millions of years ago bacteria were at work in decomposing decaying organic matter, as is proved by the formation of coal from primeval forests, of natural gas, of petroleum, of fire damp with its deadly results, etc., but it is only to-day that we begin to understand this process and the life products of micro-organisms at work in them. It is quite true that the age of man is much shorter than this, but it is probably over 500,000 years ago since man first appeared. The great Greek philosopher's words, "I know that I know nothing" are *mutatis mutandis* as true to-day as when they were uttered. It behoves us, therefore, to be very careful and guarded in all matters concerning Nature and her eternal forces.

I do not think it will be necessary for me to describe observed cases of injury to health caused by sewer air, as there are numbers of them on record and those who wish to study this subject I may be permitted to refer to my book on "Sewer Gas and its Influence upon Health," published in 1898.

A large number of cases are on record, in which men entering or working in sewers have been almost instantly killed by asphyxia through inhaling a deadly gas or gases such as ammonia, carbonic acid, carbonic oxide, sulphuretted hydrogen, etc.

In other cases septic poisoning has been said to have been brought

about by sewer gas. Here I might mention the interesting case of the executors of Thomas Henry Smith *v.* King's Norton Rural District Council, which was tried in 1896 at the Birmingham Assizes, and in which the judge entered a verdict of £2,875 against the defendants.

Then we have a large number of cases, in which observers after careful investigation came to the conclusion that there was a connection between sewer gas or air and the disease investigated such as typhoid fever, diphtheria, etc.

My own investigations confirm the general opinion that sewer air or gas is detrimental to health, and I have found that in houses with faulty drainage the general vitality of one or more members had frequently been lowered, in fact, in many cases I have not been called in until the medical attendant had suggested this cause. In one case, where the house drain was in direct communication with a foul public sewer of comparatively modern construction and where gas freely entered the cellar through a gully, the water seal of which had evaporated long ago, all the members of the family were in weak health, looked very pasty and were always subject to colds, feeling out of sorts, etc., and the milk kept in this cellar went sour after a few hours even in cold weather. In a large school for girls, whenever a case of infectious disease was introduced from outside, the soil for its further development was so favourable that there was hardly a year in which the school did not suffer from this cause. The drains were old and directly connected with an old foul sewer. I reconstructed the drainage, inserted a proper disconnecting trap, and since then the school has not suffered from this cause to anything like the former extent.

I have also reported a case of typhoid fever in a house with faulty drainage in vol. xviii, 1897, of the Journal of the Sanitary Institute.

In addition, I have also repeatedly noticed that in houses with sanitary drainage the introduction of a case of infectious illness did not lead to its extension to the other members of the family, which seems to be due to the pathogenic germs not finding a favourable soil there.

As regards the contents of sewer air or gas I have already mentioned that it may contain such deadly gases as ammonia, carbon monoxide, carbonic acid and sulphuretted hydrogen. In addition, it may contain volatile hydrocarbons and fatty acids (organic vapours, volatile ptomaines, etc.)

A considerable number of investigations concerning the micro-organic life in sewer air have been made in the last twenty years, and although some of them have been made with great care, unfortunately owing to our still imperfect methods of investigation, they have not thrown much light upon the question of its injurious influence. So far as they go, they may be summarised as follows :—

1. The number of germs in sewer air is small and less than in outside air. Whereas outside air contains on an average fifteen germs per litre, sewer air has not more than from two to nine germs per litre. Only in the case of the Sydney sewers was a considerably

higher number found, ranging from seven to 2,260 germs per litre (one litre=1,000 ccm.)

2. The micro-organisms of sewer air are related to the micro-organisms in the air outside the sewers, but not to the micro-organisms of the sewage.
3. Pathogenic germs are rare in sewer air and are introduced by the splashing of sewage in the sewers.

When we come to analyse the influence of sewer air upon health we have to distinguish—in the absence of a better definition—the direct and the indirect influence.

The direct influence may be sub-divided into two, viz., the instantaneous one and the specific disease one.

Nobody denies the instantaneous influence of such gases as I have mentioned and a large number of sad sewer fatalities are on record.

As regards the specific disease influence, the theory formerly held that sewer air or gas *per se* causes or propagates typhoid fever, for instance, has up to now not been proved experimentally. But this can hardly be surprising, when it is remembered how imperfect our methods of investigation still are, and that to find the typhoid bacillus in sewer air is almost like looking for a needle in a haystack.

In connection with this it must be remembered that Laws and Andrews had the greatest difficulty in finding this bacillus in the sewage from the typhoid fever block of the Eastern Hospital at Homerton, and that typhoid epidemics have been attributed to a water supply, although it was not possible to find the typhoid bacillus therein. Negative evidence is not equivalent to positive.

In my book on "Sewer Gas and its Influence upon Health," 1898, I observe as follows on page 57. "It will not be denied that arguments in favour of the sewer gas theory cannot in the present state of our knowledge be fully contradicted by those who are opposed to it, but, looking at the whole case and making all due allowances, it appears to the author, that the chances of typhoid fever being brought about through the conveyance of the bacillus typhosus in sewer air are somewhat remote."

I have no time to deal with the Rome experiments of Dr. Alessi, but I cannot agree with some observers, who pass over them by saying that they are incomplete and unsatisfactory, hence of little importance.

This leaves us the indirect influence of sewer gas which in my humble judgment is by far the most important. According to this theory sewer gas or air lowers the general vitality of the individual, i.e., it reduces his natural defensive or disease resisting powers, whatever they may be. If in such a reduced state of resistance, disease, i.e., disease of any kind attacks the constitution it is at an enormous disadvantage and may fall as easy prey to the attack.

This predisposing influence is, therefore, of vastly greater importance than the direct specific disease influence, as it is in the beginning of most diseases that it is felt very acutely. The beginnings of disease is practically an unknown and unexplored world, and it behoves us not to treat

this influence lightly. We have made some progress in the treatment of disease when it has got hold of our system, but it is more important to prevent disease by taking careful note of premonitory symptoms, when they occur.

Sir George Newman in his "Outline of the Practice of Preventive Medicine," observes : "We must endeavour to learn of and then remove all pre-disposing conditions which favour the susceptibility of the individual, or which weaken his natural defences. The resistant body of the patient is of no small account in our struggle with the invader, yet it is frequently neglected by the worker in preventive medicine. Ultimately, it may prove that the fortification is, in the long run, the best means of defeating the enemy. In any case, it is certain that our efforts must always be directed to the removal of conditions, in seed or soil, which make for disease. It is that and not a frontal attack against an enemy in unknown strength, which is sound strategy."

There is practical unanimity of observers in all parts of the world—England, Germany and America—that sewer air or gas is injurious to health, and must be kept out of our houses at any cost. The only difference is as to the nature and degree of this injuriousness, but that should never cause us to relax our efforts in the protection of health.

Finally, I should like to point out that the pre-disposing influence cannot be measured or gauged by comparisons of the general death rate, as this influence finds practically no direct expression in these figures.

The Disconnecting Trap.

The aim of this trap is to exclude sewer air or gas from our houses, i.e., to carry out the precepts I have laid down.

There are several good makes of these traps in the market, but I do not care for the cascade form, nor for very deep traps. I have already stated that for a four inch disconnecting trap the water-seal need not be deeper than $2\frac{1}{2}$ inches, nor the water contents more than five pints, and that for a six inch trap the depth of seal is the same and the water contents not more than nine pints.

There must be now in use in this country some millions of this trap, as the Local Government Board and now the Ministry of Health in their model by-laws have up to now insisted on it.

A number of objections have been raised against the use of the trap, which generally speaking are of a physical kind, and the late Local Government Board appointed in 1912 a Departmental Committee to investigate them, with whose report I will presently deal.

I came across a curious case of objection to the trap in the city of Cologne. They had imitated there the English practice and evidently wanted to go one better by adopting two of these traps in the same drain one behind the other. In addition they selected a very objectionable form of trap and when the inevitable happened, and they got lots of complaints about stoppages, they were greatly surprised and condemned the trap altogether.

In my humble judgment the report of the Departmental Committee leaves a good deal to be desired. It is apparently inconclusive and is certainly unconvincing. Its reasonings are not close but somewhat loose, in some parts they appear far fetched, and one misses the intimate acquaintance with the subject and the power of skilful searching analysis and interpretation. In consequence of this, some of the conclusions arrived at do not seem the logical result of the evidence produced.

But what appears its worst feature and what stamps it to some extent as an amateurish effort, is the serious mathematical miscalculation which has appeared in what the authors consider its most important part. Such a mistake should not have been allowed to pass, if the report had been carefully checked.

Further, not sufficient distinction has been made between faulty construction of the trap, its faulty fixing in the drain and its faulty, use but it stands to reason that these factors should be carefully distinguished, as faulty fixing and faulty use are purely local faults, which are due to carelessness and indifference and do not affect the principle of the trap at all.

As regards the serious mathematical miscalculation, it is stated on page eight of the report that over twenty-three per cent. of the traps examined or nearly one in every four were found faulty as to blockage. A great point is made of this high percentage. But when the figures given in the report are carefully examined it will be found that the percentage of faulty traps was only 11.38 per cent. In the report, therefore, the failures have been more than doubled and not one trap out of every four examined but only one out of every nine was faulty. A percentage of 23.49 in 12,093 gives 2,840 faulty traps, which is by 1,463 traps larger than the number of 1,377 traps actually recorded.

This mistake obviates and invalidates any conclusions based on this portion of the report and renders it almost valueless. The mistake has evidently arisen through the addition of the two averages for the first and second series of traps examined, viz., 6.85 per cent.+16.64 per cent. =23.49 per cent. and then forgetting to divide this figure by 2.063, which would have given the figure of 11.74 per cent. The same result is obtained by taking the first two series together, viz., 12,093 traps with 1,377 faulty ones, which gives a percentage of 11.38, the small difference being due to the small number of decimals taken.

From the figures of the table given on page 50 of the report it is further quite evident that to a very large extent merely local faults—improper form of trap, improper fixing and improper use—are responsible for the failures, for if in once case—District 21—only 1.5 per cent. out of 412 examined were found faulty, it seems quite clear that similar good results could and should have been obtained in other cases, if the care and supervision had been of the same order. This is further borne out by the fact that in sixteen districts the faulty traps in the first series were less than ten per cent. of the total examined.

The total population of the twenty-one suburban districts of London in which the traps were examined, is given as 1,481,000, and if we assume that there is one trap to every ten persons, an allowance which is probably below the actual number, we get a total number of traps of 148,100 in these districts, so that the total number of traps found blocked in the first series—the most important one—amounts to only 0.3004 per cent. of the total number of traps in existence, or one in about every 333. If we apply this reasoning to England and Wales (Census 1911) and assuming that there are about 3,000,000 traps in use, the number of traps found blocked in the first series amounts to only 0.015 per cent. or about one out of every 6,757 traps in existence.

It will be seen from this, that the number of traps examined is very small and in a strict and searching inquiry relating to matters of health it would be totally unsafe to rely on such small numbers for forming generally applicable conclusions.

Unfortunately it is not stated in the report whether the traps in the three series examined were quite independent of each other, i.e., fresh ones in every case, or whether some and how many of these traps were examined twice or even three times over. In a very searching inquiry this information ought to have been given, as if for instance the whole of the traps had been examined on three separate occasions their total number must be divided by three to get correct results.

Taking, therefore, only the first series of traps as being the most important, and omitting the second as being in the nature of hearsay evidence, it will be seen that in this series, about ninety-three out of every hundred traps examined acted perfectly satisfactorily, so that the chances in favour of the traps were over twelve to one. This is, however, well on the road to dead certainty that a properly constructed, fixed and used trap—quite reasonable requirements—will answer perfectly satisfactorily. If for so small a number of failures we have to condemn the trap, then every apparatus manufactured would have to be condemned. For there is no apparatus made, that however improper its use would never get out of order or could be used in perpetuity without occasional inspection.

In my opinion, therefore, the only logical and safe conclusion that can be based on the evidence produced is that a disconnecting trap under reasonable conditions can be used with every degree of confidence as regards its liability to blockage and that, therefore, this objection to the use of the trap, which has been called in the report, " the most important disadvantage " is of no effect and falls to the ground.

I need hardly say anything about the experiments made to test the quantity of matters remaining in the trap, as they are quite inconclusive. They have not been made under ordinary working conditions, a solitary two gallon w.c. flush having been used in most cases. As I have pointed out in my paper on " the passage of excreta through house drains," previously referred to, the quantity of water passing daily through the trap is much larger and I have shown there that the contents of an ordinary four inch trap are completely renewed about 104 times in every

twenty-four hours—exclusive of the water used for w.c. flushes—in the case of a one family dwelling house, which may be considered the worst case.

The next objection that has been urged against the disconnecting trap is the fresh air inlet. It has been contended that it may be damaged and the mica flap removed, so that it may act as an outlet of foul air. I have always looked upon this objection as of minor importance, and if there is an escape of foul air the apparatus is a useful indicator that there is something wrong with the house drain, which should at once be inquired into. The Departmental Report makes the following observation on this point, page 44, "the objectionable features of the fresh air inlet may be overcome apparently without detriment, by omitting the contrivance altogether."

The third objection urged against the disconnecting trap is that it prevents the ventilation of the street sewer through the house drain. That is exactly the aim of the trap, but even if such a system of ventilation were desirable the objection could only hold good, if in the absence of the trap the air in the sewers and house drain could be made to flow always in one uniform direction, i.e., from the street sewer towards the house.

But all who have given this matter their careful consideration or have made experiments to elucidate this point will know that the uniformity of flow of air in one direction is just the one thing you cannot ensure. The only law on this point that I know, is continual change, the air current being sometimes in the direction from the street sewer to the house and sometimes *vice versa*, the changes taking place very rapidly owing to influences—wind, temperature, discharges, etc., etc., over which we have absolutely no control.

This objection, therefore, cannot be maintained in the absence of the possibility of always ensuring the same direction of flow of air, and the Departmental Report bears this out.

After having dealt with the objections against the trap and shown that they are largely based on removable local faults and misunderstanding of the facts involved, I need not say much of the advantages of the trap, as they are well understood.

The chief advantage of the trap, in fact its *raison d'être*, is the exclusion of sewer air or gas from our houses and in this respect the Departmental Report observes on page 44 : "It seems to be established that the trap does serve as an effectual barrier to the entry of sewer air into the house drain."

Another important point to be considered here is the position of houses let on the flat system in the absence of the disconnecting trap. Take such a case and allow for one empty flat in the building, which is not an unreasonable suggestion ; what is to prevent the free entrance of sewer air into the building, as soon as the water seal of the minor internal traps in the empty flat have been destroyed by evaporation ? There is nothing that I know of, that would prevent such entrance in this case.

Some time ago I was inquiring into this state of things abroad in a town drained without disconnecting traps and the reply I received was the following. In such a case the owner of the building has to inform the police about the empty flat, and we then send an inspector with a lump of clay to carefully seal down the traps in this flat. I was, however, not told what becomes of the clay when the flat is occupied again. Is it again carefully removed or is it allowed to be flushed into the drain in pieces ?

Where houses in this country are drained by one combined drain the possibility exists that in the absence of the trap, sewer air may freely escape around the adjoining buildings.

With the corrections I have made I am of opinion the report of the Departmental Committee is in favour of the disconnecting trap.

In my opinion the trap forms the first line of defence against the entrance of sewer air or gas into our dwellings, it forms a necessary factor of safety, it can be relied on to act properly under reasonable conditions and its cost is comparatively trifling. Why then should it be omitted ? If this main trap is not necessary, surely the only logical result of such a contention is, that all secondary traps are likewise unnecessary.

To scrap the trap is in short in my opinion a compromise with carelessness and inefficiency at the serious risk of injury to health.

Views of the Ministry of Health on the Disconnecting Trap.

I do not know whether similar considerations as I have advanced have guided the Ministry of Health, but it appears to me that they have not taken much notice of the Report. For in their model by-laws series IV. IV*c*, and IV*a*., published in May last the Ministry still insist on the retention of the trap. All they are prepared to do is to give Local Authorities on special application to this effect a provisional option to omit the trap where the house drain is connected with a public sewer in the street, but where it is connected with a cesspit they still insist on the insertion of the trap. In other words the Ministry are still of opinion that the trap is an efficient apparatus for its purpose.

Concluding Observations.

The question of the trap has caused a great deal of controversy in the past and a good deal of sentiment has been introduced into it, but in my opinion it should be judged by calm and dry logical reasoning not from a sectional point of view, but by having regard to the question in all its bearings.

Health is a valuable asset to the State, and those who have read such reports as the late report by Sir George Newman on the health of children in elementary schools or bear in mind our large C 3 population disclosed in the late War will agree with me that we ought not to run the least risks where health is concerned, nor deliberately do anything that might endanger it.

When we can assign for every specific cause its specific effect, we may be able to relax our efforts somewhat, but until then we cannot possibly do so.

We probably stand to-day only on the threshold of the knowledge of health and disease, of life and death, and before us lies a vast unknown tract of territory which has only been explored on its circumference, but into which no solitary traveller has yet penetrated. Therefore it behoves all who are interested in matters of private and public health, always to bear fully in mind, that health is the greatest blessing man enjoys, far surpassing material wealth, and that when once it has escaped our grasp, life becomes an empty burden, a drudgery not worth to be lived.

Following the reading of this paper there was an interesting discussion, which will be printed in the next issue of the JOURNAL.

HOUSE DRAINAGE WITH SPECIAL REFERENCE TO THE INTERCEPTING (DISCONNECTING) TRAP (*continued*).

Col. F. R. DURHAM wrote :—I am particularly interested in the intercepting trap and I had hoped that my previous efforts had helped it to an eternal resting place amongst the curiosities to be found in porcelain collections of museums. I hope that this expensive and still less useful ornament to an efficient house drainage system is not trying to take a new curly attitude in life. It is valueless in a good drainage system and acts only as an impediment ; in a bad drainage system there is no use for it as everything is bad.

The only advantage I believe it has to its credit is that some ingenious persons with an eye to curves of beauties and these at a premium have managed to make an income out of their registered pets.

Efficient trapping of fittings with ample ventilation is the best maxim of house drainage. This is becoming more and more essential as the custom of direct supplies of water, etc., in living-rooms is growing fast following on the innovation of bathrooms in direct communication with bedrooms.

DISCUSSION.

Mr. T. J. MOSS FLOWER (Past President) wrote :—A paper of this kind was very much needed, as there has been of late a great amount of indifference as to the way in which house drainage work is carried out, and there is now a tendency to be careless in the planning and execution of this kind of work. I am in entire agreement with Mr. Roechling in practically everything he says, and with the conclusion he has arrived at.

I have made numerous investigations of private dwellings and public institutions in which has occurred specific forms of infectious disease, and in practically every case I have revealed serious defects in the sanitary arrangements, and which defects the medical attendants, without exception, have definitely stated that in their judgment have, at least, been contributory factors in the causation of the disease.

The statements based on certain experiments that there does not appear to be much harm in the micro-organism in sewer air, are not satisfying. As Mr. Roechling states, the direct and indirect influence on health are important factors and no one could say with any prospect of being believed that the imbibition by any person of foul air from drains or sewers, for any length of time would not at least predispose that person to an attack of any specific form of disease.

I gave evidence before the Departmental Committee appointed to investigate and report on the objections raised against the disconnecting trap, and my evidence was in support of the use of this trap. I have been

engaged in carrying out drainage work in connection with a very large number of buildings of various kinds, and in every case I have fixed a disconnecting trap on the line of drain between the building and the sewer, or the cesspool, and with two exceptions I have never known the trap to choke or cause any trouble. As regards the two exceptions, in one case a large lump of cement was found in the well of the trap, and in the other case the trap had been designedly choked for ulterior motives.

I have known most serious cases of blood poisoning and such like, to occupiers of houses where the disconnecting trap has been omitted, and where I have found the sewer gas from unventilated or poorly ventilated neighbouring sewers discharging freely into the house.

As Mr. Roechling says, the disconnecting trap forms and is the first line of defence, and minimises the evil arising from defective sanitary arrangements within the house.

The objections raised against the trap are largely due to its bad form, and unsuitability for the purpose for which it is intended, and to faults in fixing.

Personally I prefer a trap with a cascade action, but of course there are exceptions to every rule, and in some cases they would be unsuitable.

It is said that an ounce of practice is worth a ton of theory, and Mr. Roechling's paper judged from this standpoint will put the hall mark of high value upon it, and I should like to heartily congratulate him on his very valuable contribution to the proceedings of the Institution.

Mr. C. W. Sreeves (Associate Member) said that one experience he had had was with a new estate of 130 houses and no disconnecting traps were used. He had watched this estate very carefully and after all the houses had been occupied for a while he had a manhole cover taken off and it was possible to stand over it and not detect any objectionable smell. There were two vents to each pair of houses. In another case in an estate of 1400 houses, intercepting traps were fitted and experience showed that 90% of the blockages of the drains were at the intercepting trap.

In a written communication Mr. Sreeves continues :—Acting on the suggestion of the President that any further remarks on the discussion might be sent in, I venture to send you a few notes on my experience in house drainage. First of all allow me to say that however much we may differ in opinion as to the abolition or use of the intercepting trap a good deal of credit is due to the writer of the paper.

After all it is only by such discussions—as took place at the meeting—coupled with actual experience that we are led to alter our views on any particular subject. Further it is only after attempting to write a paper that one realises the great amount of time and care required in preparation. Some ten or twelve years ago the question of for and against the use of the intercepting trap was very freely discussed through the columns of *The Surveyor and Engineer* which I followed very closely and have often regretted not keeping the copies in question. Now I have to confess that it was only after a good deal of experience that I was convinced that

the intercepting trap was not necessary to ensure a perfect system of house drainage.

Referring again to the estate I mentioned at the meeting. This system has and is still, working most satisfactorily.

One hundred and thirty houses were connected in groups to a series of six inch common drains connected to the sewer. Not a single inter cepting trap was used anywhere on the system. The branch drains from each house discharge into an inspection chamber to which a four inch vent pipe is connected (one vent to each house). For bath and sink waste.

"The Brankstone Gulley" was used, viz., a reversible top gulley with upright back inlet. This type gulley dispenses with the channel and brick or cement curb with the waste discharging eighteen inches away from the gulley inlet (as per by-laws). In my opinion a most objectionable and insanitary arrangement, but still insisted on in most rural districts and provincial towns.

Referring again to the ventilation.

The cover of the manhole of sewer nearest to but below the houses—can be taken off and no objectionable smell can be detected.

Let us now consider for a moment the ventilation under this system as compared with a system on which the intercepting trap is used.

In the first case we have 130 four inch vents as against one or perhaps two six inch ventilating shafts to the sewer (according to the layout of the building area). The 130 vents would in my opinion *prevent* the formation of sewer gas, whereas on the other hand foul air or gas would be discharging from the ventilating shaft to the sewer, in one or two very small areas.

Re sewer gas passing through the house fittings.

To the bath and sink waste we have two water seals, one to the gulley outside and one to the trap inside the house. Also a water seal to the w.c. pan. All connected to branches discharging into an inspection chamber from which chamber the connection to the vent pipe is taken.

Now assuming that there is a collection of sewer air or gas (which I have already doubted) are we to believe that it will penetrate or force the water seals of the fittings in preference to ascending the vent pipe? Surely the gas would take the least line of resistance and go up the vent; but someone may say—and if my memory serves me correctly it was said at the meeting—the vent pipe might be blocked up with shale off the pipe (to-day we use pipes coated with solution to prevent that kind of thing) so might any other part of the drain especially the intercepting trap. To my mind it is rightly named, it does intercept, often matter that would otherwise pass into the sewer, but we are not dealing with badly constructed or neglected drains, so I must not get off the track.

Another system that came under my notice and again a new estate of just over 200 houses all fitted with the intercepting trap, and the so-called fresh air inlets which were six inch by nine inch terra cotta air bricks fixed in small brick piers from twelve to eighteen inches high (no mica flap). In reality foul outlets.

There were two six inch ventilating shafts about twenty-five feet high connected to the sewer from which foul air could be detected when standing on the opposite side of the road.

If this state of things could be observed in the public highway what about the bedroom windows to the houses in close proximity? Subsequently another fifty houses were built and the intercepting trap omitted. The extra fifty vents so improved the whole system that the objectionable smell from manholes and sewer vent shafts disappeared.

One other instance.

An estate of 1400 houses in a London district—I mention London district simply because the supervision is usually more severe. All the drains were inspected and tested by the Local Authorities, with water when first laid and smoke when completed, so that there was no question of faulty or badly constructed drainage. I remember one building inspector in the district who always carried a gauge with which to test the depth of the water seal to the intercepting trap before passing the drains. I was in charge of the maintenance department of this estate for about four years.

A careful record was kept of all repairs, drainage, etc., and I invariably found that blockages in the house drainage were due to the intercepting trap. One has only to see the state of inspection chambers and gullies, after a stoppage which has been in existence until the foul matter forces its way through some of the traps, to realise the disgusting state of the house connections, a state of things which would very often be avoided by the omission of the intercepting trap.

A blocked drain frequently gets to the stage mentioned before the occupants of the house are aware anything is wrong.

A final word on ventilating shafts to public sewers.

It would be interesting to walk through some of our towns and note the number of vent shafts, also their height. I venture to say that in a good many instances the top of the shaft (or outlet) is far below the windows of some of the domestic dwelling and public buildings, especially in hilly districts. Should any of our members feel disposed to write a paper on the abolition of the intercepting trap and would care to use any of my notes, you are at liberty to pass them on.

Mr. A. J. Martin (Past President) said the paper was an admirable treatise on sanitation in general. The author had delivered himself of a number of maxims with regard to the value of health with which everyone was in entire agreement; but they threw no light at all on the question of the utility or otherwise of the intercepting trap. The dominant note of the paper was an appeal to prejudice. For instance, there were repeated references to "sewer gas," though the author could hardly fail to be aware that there was no more justification for applying the term "gas" to the air of an ordinary sewer than to the air of a room. He said, too, that sewer air may contain such "deadly gases" as ammonia, carbon monoxide, carbonic acid and sulphuretted hydrogen. It was an abuse of language to speak of ammonia and carbonic acid,

in the concentrations in which they were found in the air of a sewer, as "deadly gases." There was probably as much "deadly" carbonic acid in the air of that room as in that of an ordinary sewer. Then, again, the author had drawn a lurid picture of the state of the air in a city with miles and miles of underground pipes, culverts and brick channels. There were doubtless cases of that kind; but there were many others which were quite different; and it was unfair to suggest that there would be the same state of affairs in the one case as in the other. In a fair-sized town it would be safe to say that the distance from the furthest house of the sewer outfall would often not exceed three miles. It was customary to aim at a velocity of at least 2 ft. per second. If they called it 1½ ft. per second, or one mile per hour, the sewage from the furthest house would reach the outfall in three hours. It was impossible, in such a system as that, to have the conditions described by the author.

Mr. Roechling had made great play with our imperfect methods of investigation. Undoubtedly we had a great deal to learn as to methods of investigating a problem like this; but what he (the speaker) gathered from the paper was that we must discredit every investigation the results of which were unfavourable to the views held by the author.

Mr. Roechling had made a very unfair attack upon the report of the Departmental Committee. He endeavoured to belittle their conclusions on the ground that "the number of traps examined" (only 12,093!) "was very small." He (the speaker) did not think anyone else would reject the Committee's conclusions on that ground.

The author insisted that the work of the sanitary engineer should be absolutely above suspicion; yet he went on to say that an appliance which fails in seven cases out of every hundred "can be used with every degree of confidence." Not many engineers, he imagined, would be satisfied with such a standard in their own work. Mr. Roechling suggested that, if every one of these traps had been "properly constructed, fixed and used," they would all have answered perfectly satisfactorily; in this world, unfortunately, they had to deal, not with things as they ought to be, but with things as they were.

The author went on to state that the contents of an ordinary 4-inch trap were completely renewed about 104 times in every twenty-four hours. That might be the case if nothing but clean water passed through the trap, but it certainly did not hold good with sewage.

In view of the stress which was laid throughout the paper on the dangers of sewer air, it was somewhat of a shock to be told on page 118 that an escape of foul air from a defective fresh-air inlet, possibly near windows or in the midst of a group of playing children, was a matter of "minor importance," and "a useful indication that there is something wrong with the house drain." The author appeared to forget that the emanations from a drain may be dangerous without necessarily being palpably offensive.

The statement which follows was hardly less surprising when they remembered that the whole paper was one long plea for the exclusion

of sewer-air from the house drains. The use of the latter to ventilate the sewers is only desirable, according to Mr. Roechling, "if in the absence of the trap the air in the sewers and house drains could be made to flow always in one uniform direction, i.e., from the street sewer towards the house." Would the ventilation be any the less effective if the soil-pipes occasionally acted as inlets for fresh air and not always as outlets ?

He (Mr. Martin) found it difficult to reconcile the author's child-like faith in the disconnecting trap with his profound distrust of the traps in the house. If the former could be made so absolutely efficient, why not the latter ? And if the interior traps could be made so reliable that the disconnecting trap might safely be dispensed with, how could it be "only logical" to scrap the interior traps also ?

Such contentions as these furnished a sad illustration of the straits to which a good man is reduced when he is struggling with a bad case.

Mr. O. Cattlin (Chairman of Council) thanked the author for submitting this paper and said that although he could not correctly say it was a hardy annual, it was, nevertheless, a good old topic revived. As a preliminary remark with regard to the use of the intercepting trap he would say to the author, "Having won, why labour the subject ?" He was old enough to remember a good deal of the discussion for and against its use and had served under engineers who were whole heartedly in favour of its abolition. But the party for abolition having persuaded the Ministry of Health to leave the inclusion in a local authority's by-laws an optional matter, overlooked the difficulty of application or at least failed to foresee the result. It was now seen that it was impossible satisfactorily to have a partial use of the disconnecting trap. Either there must be a free outlet at the head of each branch drain for all sewer or drain air, or each system must be left to look after its own interests. A portion of the inhabitants could not be permitted to provide the ventilation because it would be too strong for the traps of an ordinary yard gulley. The drainage of large isolated buildings would be a good test for the omission of the disconnecting trap but he imagined that very few sanitary engineers took this step. This in itself shewed that there is a large majority in favour of the retention of the trap. Looking back on the agitation for the abolition of the disconnecting trap, it must be admitted that where this step was supported by municipal sanitary engineers it was with the desire to have a free flow of sewer and drain air through the numerous foul air outlets at the head of the drain. Sewer ventilation was a difficult matter and whilst he was prepared to go into the whole matter and yet support the use of the disconnecting trap, at the same time he must point out that the position was unfair. He was at one time associated with a municipal engineer who pointed out that if sewers were open, there would be a minimum of smell. Up-cast shaft ventilation was practically the only thing to-day. Surface grids necessarily emitted foul odours when there were so few of them. Speaking

from long experience he could say that many stoppages occurred in drains at the disconnecting trap, especially the access interceptor. In his own borough there were many thousands of access interceptors but he did not condemn them because some became choked. Good workmanship was necessary in fixing a trap, and he had seen many incorrectly set. Having installed a new system of underground drains, and then stopped the whole thing with one of the fittings, did not bring bouquets for the engineer of the scheme. Fresh air inlets were very often foul air outlets and they should be carried up above the roof as was done at Eastbourne and other towns. The paper dealt with house drainage generally but he was inclined to think we have not made much progress in that connection during recent years. The London by-laws, for instance, were twenty-one years old and surely there was something wrong if these were still up-to-date. With regard to the failings of the old type of sanitation, criticism of this he always felt to be a little unfair. Our ancestors did not have the modern appliances now available and to appreciate this one had only to look at the history of a firm like Doulton's. It was only comparatively recent times that sanitary stoneware glazed tubing had been introduced and we should appreciate the conditions under which the old sanitary engineers carried on their work. Even now there were some places which were behind in the matter of sanitation perhaps, because there was no real need for it, but speaking generally, he felt there was one very grave neglect and that was periodical inspection. A large percentage of house drains were not examined periodically and they were defective in the light of what was regarded as modern drainage and were, no doubt, emitting some drain air. Hence the necessity for keeping the underground drains outside the premises. As a general conclusion on the question of retaining the disconnecting trap, he believed the findings of the Committee were absolutely correct, viz., that the use of it should be determined in the light of local circumstances. In the case of a new town no doubt the abolition of the trap would be the best thing, but in the case of existing systems there could not be a partial lifting of the requirement.

Mr. C. H. Roberts, said the author appeared to assume that the Ministry of Health were generally in favour of retaining the trap. He (Mr. Roberts), was not now in the Ministry and was not in any case authorised to speak for the Department, but he ventured to say that the author's assumption was quite incorrect. There was an official of the Ministry present who might or might not wish to refer further to the matter.

Mr. A. P. I. Cotterell (Past President), said he was wondering whether anyone would be found to support the use of the disconnecting trap. At first sight it appeared that the author had made out a most convincing case for the retention of the trap, but he had really raised so many bogeys with regard to the conditions of the sewers that people might almost be led to think they could not go safely to sleep unless they had an intercepting trap. It seemed to him that sewers were often painted

blacker than they really are. He did not wish to minimise the danger of sewer gas because there was the risk of indirect danger through a lowering of the system and consequent encouragement to pathogenic germs, but the fact was, as Mr. Cattlin had said, our sewerage systems had been enormously improved during recent years and it was time we overhauled some of the protective devices which were adopted in the days when sewers might, perhaps, be elongated cesspools and before the introduction of glazed stoneware pipes and so on. It must be remembered that the conditions in sewers to-day were altogether different from what they used to be. Reference had been made to America and he was inclined to think, from visits he had paid there, that as regards house drainage American practice is in front of British practice. Certainly the Americans were good at plumbing. He believed he was right in saying that as a general rule American practice was in favour of omitting the disconnecting trap. Col. Durham's letter had also impressed him in this connection because Col. Durham had had a long experience in sanitation on the continent, especially in Frankfort which was one of the foremost cities in Europe in the matter of sanitation and therefore the views of Col. Durham ought to carry great weight. Did the author think that the trap is really the chief factor in house drainage? This was stated to be so on page 107, but he himself preferred the statement on page 110 of the paper where it was submitted that the drainage system should be so designed as to effect the speedy removal of all waste organic matter from the interior of our houses as fast as possible. If that were so, then surely the disconnecting trap stood condemned because it helped to hinder the rapid transmission of sewage from houses? The whole object of sanitary engineers was the rapid conducting away of the sewage from centres of population. It was true that some kind of septic action might be set up during the passage of sewage through a long length of pipe but the risk of that was now very slight, having regard to the fact, as Mr. Martin had pointed out, that the distance from the drain to the sewage outfall is, at most, generally only a matter of a few miles. He had been associated with a city—Bristol—where ventilation of the sewers has not been introduced and it was extraordinary how inoffensive on the whole the sewer air was in a place where one would expect it to be very foul indeed. He knew there were cases where men had been damaged through breathing sewer air, but these were exceptional cases, and under ordinary conditions, if the sewage was carried away with ordinary rapidity, there was not the danger from sewer air that the author had suggested. A previous speaker had pointed out how little the contents of a trap did get flushed. The whole contents were not removed and that this was so was demonstrated very clearly at a discussion at the Institution of Civil Engineers on the previous night when one of the speakers dealt with the effect of baffles in large tanks. It was shewn upon the screen that instead, as was generally thought, of the effect of the baffles being to cause the water to sweep out the lower portion of the tank, the water on entering went direct from the bottom of one baffle plate to that of the next and the base of the tank was left practically

untouched. That was also the action of the intercepting trap. The other day he was at a Poor Law Institution and when the manhole containing the intercepting trap had been opened, it was found that the trap was blocked. There was a vast difference between the intercepting trap at the outlet of a house drain and the local traps to the fittings and the difference was this. Take a closet pan. It was impossible to clear a closet pan thoroughly unless there was a good flush with plenty of fall. In modern pans there was a thorough clearance. The same applied to the sink trap. There was a flush from a certain height and the sink trap cleared itself, but we did not get that with the house intercepting trap. The gradient of the house drain was somewhat flat and it was impossible to ensure the gradient one would like to have for flushing purposes. The consequence was that liquid charged with solid matter reached the intercepting trap, but the flush was not sufficient to carry all the liquid and solid matter through it. That was different from what happened in the case of the local traps to the fittings and it was one of the reasons why many people thought the intercepting trap was an obstruction. He agreed with the author, however, that under certain circumstances the trap is absolutely necessary and that it could not be swept away entirely. There were bad sewers still in our cities and the public must be protected against them because they were practically the same as cesspools. It might even be necessary to put an intercepting trap between a well drained and a badly drained portion of an area but in that case the trap would be in the charge of the local authority and could be maintained in thorough condition. How often were the intercepting traps on house drains examined? Moreover, the installation of the intercepting trap was not an inexpensive thing because there was not only the trap but the manhole and inspection chamber which added a considerable amount to the cost of house drainage. Only a short time ago there was a discussion at the Royal Sanitary Institute when the question of reducing the high cost of house drainage was considered and the large sum involved in the trap and inspection chamber was mentioned as one of the causes of this high cost. In thanking the author for his paper he wished specially to mention the definition of Sanitary Engineering he had given on page 106. It was a splendid definition and put in a few words what we had all wanted to say again and again. Even if the paper contained nothing else, sanitary engineers would be grateful to the author for this.

Mr. C. E. Tyler said that when experts disagreed, as they appeared to be doing in this matter, what was the ordinary man to do? Speaking as a member of the public, all he could say was that the public will not have smells from drains whether they be injurious or not. The fact that they were objectionable was sufficient and he thought the discussion had brought out the fact that where sewers themselves are inoffensive it did not matter whether there was an intercepting trap or not. Where, however, sewers were offensive then the intercepting trap was still an absolutely necessary thing.

Mr. GENTRY said his opinion was that if the drains under houses are thoroughly sound then it will be quite safe to do away with the intercepting trap. The first cause of most stoppages was the blocking caused by the trap and it was very often not known that the traps were blocked until a large amount of sewage was found at the back gulley. He had found from a systematic house to house examination that sixty-nine per cent. of stoppages were caused by the intercepting trap and it followed that if the trap was abolished there would be a free flow for the sewage. One thing to be remembered was that the ordinary two gallon flush only gave an effective flush of one and a half gallons because the other half gallon was clinging to the sides of the pipes. A flush of one and a half gallons was not sufficient to clear the solid matter through the intercepting trap although it might clear the liquid and so it followed that with each flush there was an accumulation of solid matter which eventually caused a blocking of the intercepting trap. The fall in the drains of course, had some effect but in most cases the fall was not sufficient to result in a one and a half or two gallon flush being thoroughly effective every time. Therefore, on the whole he felt that the intercepting trap ought to be done away with. As regards the purity of the air in sewers, the death rate among men engaged in sewer work was very low and the real danger was not in sewer gas itself, but in the marsh gas which was found in the bottom of the bed of sewers and was given off when the sewage was stirred up. Sometime ago a Royal Commission issued a report in which a case was mentioned of back-wash in a certain drainage system which carried diphtheria germs through the drains to a house several doors away from where the diphtheric patient was. It was found that the germs had hidden inside the intercepting trap and the diphtheria was conveyed to the other houses. Looking at the matter generally, however, he believed that in the long run a more effective and least dangerous drainage system would be secured if the intercepting trap were done away with.

Mr. GEO. W. CHILVERS (Life Fellow), said he supported the use of the disconnecting trap and believed that sewerage engineers who wished to abolish it did so solely with the motive of being able to ventilate their sewers through the drains. As the author had said, modern sanitation in Great Britain was second to none in the world, and, providing the work was carried out by qualified men it would continue to be so. He believed the disconnecting trap was of great value, and during forty years' experience he had met with two cases only where the trap was blocked. In neither case was the blockage due to any defect in the trap itself; one being caused by the flooding of a sewer too small for its work during a period of heavy rainfall, and the other owing to carelessness on the part of a workman who left an empty smoke rocket in the drain.

If the institution continued to carry on its work of seeing that only qualified men were allowed to engage in the profession of sanitary engineering there would be no need to discuss the question of abolishing the dis-

connecting trap. He had known of many cases of illness through foul gases getting into the houses from defective drains and fittings, and he, therefore, could not agree that by ventilating the sewers through the house drains they would in any way lessen the risk of this, and was convinced that the disconnecting trap should be retained. In his opinion there were several other reasons why sewers should not be ventilated through house drains. Amongst these were the risk of infection from other drains, and the probable undue interference of Local Authorities with the right of an owner to have the sanitary arrangements of his house in accordance with his own desires, and not with the view of providing for the best method of ventilating the sewers. At present, if the sanitary arrangements of a house were installed on modern lines, and carefully executed, and properly maintained it was a complete system in itself, and was quite safe ; whereas, if the disconnecting trap were omitted, the whole became only a part of the system common to the whole district in which the house is situated.

Dr. S. W. Wheaton (Ministry of Health), who was asked by the Chairman to express some views on the subject said he felt it would be wiser for him not to discuss the merits of the case, but he suggested that the Institution should endeavour to collect some information as to the manner in which the large number of drainage systems which had been erected in recent years without traps had worked. Information was wanted as to their efficiency or otherwise.

The President, Mr. J. S. Alford, in moving a vote of thanks to the author for his paper said that the Institution was indebted to Mr. Roechling for raising a discussion on a matter which was still undetermined and needed more light thrown upon it. He agreed with the statement in the third section of paragraph 135 of the report of 1911 of the Committee appointed in 1908 which read as follows :—" As circumstances in this respect will vary in different localities, the question whether, in order to prevent nuisance from smell in such exceptional cases, the intercepting trap is or is not required in any locality, or part of a locality, is one which will need to be considered and determined by the local authority, and their advisers, in the light of local conditions. Where, however, the trap is considered to be necessary or desirable, the measures for providing against the effects of blocking of the trap should not be neglected. . . ." The circumstances of which the Committee were speaking were those such as sewage giving off offensive odours, drains connected with sewers of deposit, houses built in terraces at different levels, and so forth. In short, local circumstances constitute the dominating factor. He thought that it was seldom that local circumstances permitted the trap to be dispensed with. The author had called attention to the factor of safety and that was a consideration which should not be left out of account. Again, comfort as well as health must be considered.

During the construction of the earlier works of the new Dublin main drainage system a length of sewer was built and shut off so that no sewage entered it. That sewer became charged with some harmful gas and two men who entered it lost their lives and others who attempted rescue were temporarily disabled. If the gases which caused that accident found access to a newly constructed brick sewer there seemed no reason to assume as a certainty that they would not enter sewers in which sewage was running. The danger was not disposed of by proving the harmless nature of emanations from sewage and the high standard of health among sewer men. It was better to put in many traps than to run even a small risk of the entry into dwellings of gas which when present in quantity was capable of causing death.

He was of opinion that the cases where the trap could be omitted with safety were small relatively to the whole number and to that extent he was in accord with the author. It appeared to him that rather too much stress had been laid on the number of defective traps recorded in the report of the Committee. It was most unlikely that all the traps examined were of satisfactory type. If a badly designed trap blocked, the fact did not condemn the practice of trapping unless no satisfactory trap could be found to replace it.

Having said so much in greater or less support of the author's views he felt himself obliged to disagree with certain paragraphs in the paper. In particular he took exception to the statement on page 24 that there was a " serious mathematical miscalculation " on page 8 of the report of the Committee. At the place referred to—paragraph 24—the Committee said : " Eventually, in response to our request, 6492 intercepting traps were examined in twenty-one sanitary districts with results that are shewn, in detail, in Appendix II. Of the traps examined 445 or 6.9 per cent. proved to be blocked at the time of examination. Particulars of previous blocking were given in regard to 5601 traps and of these 932 or 16.6 per cent. gave evidence that at one time and another they had been blocked sufficiently to cause an accumulation of sewage in the inspection chamber."

He submitted that the proper construction of this paragraph, was that the total number of traps examined was 6492 and not 12,093 as stated by the author. Support was given to the speaker's view by the third section of paragraph 125 of the report where the Committee said " This unsuspected blocking of the trap and accumulation of sewage appears to be very common, evidence of it having been found in more than twenty-three per cent. of 5600 traps which were specially examined." There the Committee were dealing with both defects, and if 12,093 traps had been examined, surely they would have said so. There was nothing in Appendix II. which helped the author's contention. That Appendix was quite consistent with the paragraphs already quoted. It was headed " Results of examination of intercepting traps in twenty-one suburban districts," and contained only one column giving total numbers, and that column added up to 6492. The note as to the

5601 traps at the bottom of the page might be ambiguous if read by itself but it was not so otherwise.

The Committee were undoubtedly right in adding 6.9 to 16.6 and so producing a total of 23.3, subject to the small error resulting from the two percentages having been calculated upon the numbers 6492 and 5601 instead of upon equal numbers.

The author himself did not seem to be quite sure of his ground because he said on page 25, " unfortunately it is not stated in the report whether the traps in the three series examined were quite independent of each other . . ." Alleged ambiguity is not necessarily error.

Judging from the first paragraph on page 25, he was inclined to think that the author lived in a glass house. That paragraph contained something more serious than a mathematical error ; it was fallacious in argument. The relation between the number of traps found blocked in the selected areas and the total number of traps in England and Wales was of no significance. It was not clear why the survey was limited to England and Wales : the reasoning would apply equally well to the Stellar system.

Mr. Roechling, acknowledging a cordial vote of thanks, said he would not have time to reply to the discussion in detail, and would do that in writing.

The Author's Reply on the Discussion.

In replying to the discussion, he was glad to notice that some speakers had vigorously attacked his paper, as he looked upon a strong opposition as the best means of driving his own conclusions home. On the whole support and opposition had been fairly evenly divided.

In the past, the matters raised in his paper, especially the disconnecting trap had been treated by some, as if they were a matter of faith equivalent to religious belief. To him it was nothing but a matter of dry and careful argument, in which all sentimental considerations should be rigorously excluded, and if everybody were to consider in this spirit the points he had brought forward in his paper, he thought the opponents, or at any rate, some of them, might eventually come round to his view.

The lure of novelty was very strong with some of them, and what had been called " herd instinct " was a powerful factor in swaying public opinion, but, as it was wholly unreasoning and caused stampedes first in this and then in the opposite direction, it ought to have no place in either scientific or practical considerations.

Apart from this, the abandonment of the disconnecting trap was not progress, i.e., a step forward, but the reverse of it, i.e., a step backward, as it was a reversion to what had been before 1875, and to what had been condemned, and let there be no mistake about this. If some

wished to join the "back numbers" by all means let them do so, but let them do so at any rate with their eyes open.

He hoped, that when they had read his criticism of that part of the Departmental Committee's report, which dealt with the physical or engineering features of the disconnecting trap and especially the provincial results with the trap given in the evidence, they would agree with him, that the trap was a remarkably good apparatus and had fully established its claim to life. The provincial results, though obtained by the Committee, had been totally ignored in the report, and this complete silence was to say the least most mysterious and quite unpardonable. Was it accidental or was it intentional? The provincial results completely contradicted the results obtained in the London districts and the only explanation he could offer for this difference was that some of the districts referred to must have been the happy haunts of the jerry builder, who, as was well known, had flourished far more in London than in the provinces. Had these provincial results been duly considered by the Committee, they could not have made the observations they did make. It almost looked as if the wish to condemn the trap had been father of the thought, but he would leave any inferences on this point to his readers. As it stood, this part of the report must go for good and all.

He would like to make at first some general observations about the aim of his paper, as he was afraid it had been misunderstood by some. It had been remarked, that he had introduced matter that had little or no bearing upon the subject, that he had employed the art of special pleading and had raised bogeys. Nothing was further from his mind, and these accusations would disappear by a more complete understanding of the aim he had had in view.

He was speaking before an audience principally composed of sanitary engineers, and he had noticed that in the past they had not given sufficient attention to the problem itself and its underlying questions, but had confined themselves almost exclusively to the present solution of it, i.e., the disconnecting trap. This had led to a good many confused views, and he was anxious to remove this confusion of thought about a really quite simple matter. For this purpose he had endeavoured to deal in his paper comprehensively with his whole subject, setting forth first the underlying questions, then the problem itself and finally the present form of its solution, so that his audience might be in a position to judge of the matter from all its aspects.

What were the underlying questions, what was the problem, and what was its present solution? The underlying conditions were the injurious character of the gas or air in our sewers upon health; the problem set sanitary engineers by preventive medicine or its branch hygiene was the exclusion of this gas or air from our dwellings, and the solution of the problem in its present form was the disconnecting trap. These three points must be considered together, and whilst the first two remained, it would be wrong to drop the solution altogether by abandoning the disconnecting trap. If, as some thought, the present form

of solution of the problem was unsatisfactory from a physical or engineering point of view, an opinion which the thought was not justified, as he had endeavoured to show, the only correct way out of the difficulty would be by suggesting a better form of aerial disconnection between the sewer and the house. To abandon the solution altogether was, in his opinion, totally illogical, and involved a serious danger to health. First the problem and then its solution !

Our views were subject to change in the present state of very incomplete knowledge, but so far preventive medicine had never expressed the opinion, that the gas or air in sewers was not injurious to health and had insisted almost unanimously in all parts of the civilised globe, that this gas or air must be excluded from our houses. Nobody at this meeting had disputed this. It was true that our views as to the epidemiological character of the danger had undergone some modifications, but the danger in other directions was still there and could not be neglected.

Some few people had, on the strength of published health statistics, come to the conclusion that sewer gas or air was apparently not dangerous to health, but such views were, in his opinion, based upon superficial knowledge only. For the published health statistics were far too crude to permit of very fine distinctions or to recognise influences in them, that found practically no expressions at all in them, and without knowing all the conditions governing the health in two houses or two towns, which they did not, such a comparison was probably totally misleading. In health matters they could not be dogmatic, but must ever be cautious !

When they were in a position to assign for every specific effect the specific cause, they might then lay down dogmatic views, but until then it was short-sighted and superficial to do so.

It had been maintained by some that the problem of excluding the gas or air in sewers from our houses was sufficiently solved by leaving out the principal trap—the disconnecting trap—and relying solely on the secondary—partly internal—traps. He was afraid such a contention could not be maintained, as all secondary traps were less reliable than the disconnecting trap, they being far more subject to temperature influences and other disturbing conditions (vibrations, careless use, etc). If one of them failed all the others were practically useless, as the faulty one might admit sewer air or gas into the house. He would only remind them of gullies for cellar drainage and outside the house for rainwater, the water seal of which quickly evaporated in hot weather and allowed in the absence of the primary trap the gas or air to escape outside and probably come in through open windows, etc.

The w.c. trap was in its form from a purely engineering point of view far more objectionable than the disconnecting trap, and he had had far more often to do with the blockage of this trap through careless use or inefficient or insufficient flushing power, than with that of the disconnecting trap, which had given him very little trouble. He was speaking from very considerable knowledge on this point, as he had

for years superintended the sanitary fittings of a large number of working-class houses in a suburb of a Midland town, some of which were inhabited by a migratory population.

It had also been urged that the disconnecting trap was a very expensive apparatus, but apart from the inspection chamber, which was almost universally held to be a necessity, the cost was only from half to one per cent. of the cost of a working-class house. It was certainly cheaper than the cost of a serious illness of even moderate duration, but in health matters no expenditure should be grudged !

He had so far not said anything about the gas or air in house drains, and did not intend to say much. Some people maintained that the air in house drains with the disconnecting trap was frequently as foul as that in the public sewers, if not worse. He had pointed out in his paper on pages 109 and 110, that his long experience did not bear this out, that on the contrary, he had generally found this air perfectly sweet, and when he had come across a foul house drain he had traced it to local faults, such as a badly laid drain (want of proper supervison in laying), improper use, inefficient discharge of flushing water, etc., etc. The best remedy for a foul house drain was periodical inspection by the authorities, and where this was done, as for instance at Willesden, complaints would rapidly disappear. In a house drain they could avoid conditions giving rise to foul smells, whereas in a sewerage system, especially in large towns, such conditions could not be avoided.

The argument that with modern sewers carefully designed, constructed and maintained, the disconnecting trap could be dispensed with, was entirely fallacious. For all new sewers would in course of time become old, and even with careful supervision foul gases and smells could not be avoided in new sewers. Experience had shown this in many towns, and he would only mention two towns Frankfort-o-M. and Pretoria. In addition to these, their President had mentioned the case of a sad accident involving the loss of life in a Dublin sewer, that had never been used before for carrying sewage, and he, the author, had also mentioned a case in his paper.

Valuable testimony to the efficacy of the disconnecting trap had quite recently been supplied by Mr. F. Wilkinson, the engineer to the Willesden District Council, in his letters in the *Municipal Engineering and the Sanitary Record* of the 29th of January and the 12th of February last, which should be read by all interested in this question.

Coming now to the written discussion, it seemed to him that Col. Durham was disappointed that the disconnecting trap was still flourishing vigorously in spite of his attempt to relegate it to a museum of porcelain curiosities. Col. Durham seemed to have misunderstood the problem that had to be solved, or had only looked at it from the standpoint of the constructional engineer, and not from the standpoint of the hygienist.

He, the author, did not think they would ever in this country adopt the house drainage practice in use in some towns of the continent, with which Col. Durham had been connected, and which he had described

to the Departmental Committee. There, according to him, house drainage was looked upon by the authorities as an integral part of the sewerage system of the town, and they claimed the right to ventilate the street sewers freely through any or all of the fall pipes of the house drainage, which, with the exception of the rain water pipes were all internal pipes. This meant that no house owner could fix a disconnecting trap, even if he wanted to do so. The sewers had open manhole covers even in important thoroughfares and the house drainage pipes were only inspected from outside but not tested.

Yet, in spite of this copious ventilation, and in spite of the sewers, for instance, in Frankfort-o-M. being practically all modern, excellently designed, constructed and maintained, they had been obliged, according to Col. Durham, to construct special ventilating shafts in places owing to complaints of foul smells.

He looked upon the system described by Col. Durham as laying the gas or air in the sewers systematically on to the dwelling houses, and even if this gas or air did not escape through cracks or weak joints in the internal pipes, it might come in through windows or doors from the rain water pipes, which were constructed of light iron pipes.

Major Moss-Flower's letter contained valuable testimony to the efficacy of the disconnecting trap and should, he thought, be carefully studied by all interested in the subject.

Coming now to the oral discussion, he thought it would be more convenient and save time to combine the more prominent observations under the different aspects of the question than to deal with each speaker's observations separately. He hoped they would excuse him doing so.

It had been observed that the remarks he had made about the report of the Departmental Committee were not borne out by facts, but he begged to differ, and would endeavour to show, that they were perfectly justified.

Their president had said that the serious mathematical miscalculation in the report, to which he had drawn attention, did not exist. He, the author, had again carefully examined it, but was sorry to say could see no reason to alter his view. If there was no error, then the language of the report was so ambiguous, as to mislead, and in an official report this was probably worse than an error.

All depended on how the three different conditions of the traps had been counted. If they had all been included in one count then the averages given in the report were correct, but if three separate counts, one for each condition, had been made, then the averages given were wrong.

The report gave them no direct guidance in this respect. On page 8 the figure of 6492 traps examined was given, whereas on page 44 this figure had been reduced to 5600 traps. Which was correct? Again, on page 50, in a footnote, it was clearly stated that 5601 traps were examined for the second and 6295 traps for the third condition without a hint that they were included in the figures of 6,492 traps examined for the first condition. He did not think the arrangement of the table

settled this point without a clear statement to this effect. Further, the first footnote on page 8 mentioned a series of trap examinations, and coupled with omissions in the table on page 50 and the remark on page 8, that *eventually* in response to the Committee's request, a number of traps were examined, he was of opinion, that the view he had expressed as to a serious mathematical miscalculation was the correct interpretation of an ambiguous language.

But apart from this, the table on page 50, on which the Departmental Committee principally relied to prove the unsatisfactory form of the disconnecting trap, was open to further serious objections, which he would point out.

It was assumed in the report that the figures given in the table could be relied on as giving the correct average conditions existing in the districts partially examined. But did they?

Nobody would deny that in order to obtain absolutely correct figures in this respect, the whole of the traps existing in a given district must be examined, and that an examination of a portion only of the traps could only be an approximation to the true state, the approximation being the closer the greater the number of traps examined, and the more unreliable the smaller this number.

Take the case of a district with 1000 traps in all, and assume that all of these had been examined and 100 faulty traps discovered, which would give ten per cent. of faulty ones as the correct average for the whole district. Then assume that only 500 with 75 faulty traps had been examined, which would give fifteen per cent. of faulty traps not as the average for the whole district but solely as the average for this count only. Finally, if only 100 traps had been examined with fifty faulty ones they would get an average of fifty per cent. of faulty traps for that count only. For this district they would then have three percentages of faulty traps, viz.: the correct average of ten per cent. for the whole district, the approximate average of fifteen per cent. for the second count only and the average of fifty per cent. for the last count.

He contended that to base any conclusions on the second and especially on the third percentage as the correct average for the whole district was utterly wrong, and totally unscientific. Such a return was worse than useless, it was entirely misleading.

They had no figures for the total number of traps existing in each district, but taking for the purpose of the argument ten persons to one trap, which assumption was probably near the truth and a convenient figure for calculation, and what error there was would be common to all districts, he found from the population figures given in the table, that the percentages of the traps examined out of the total number assumed to be in existence differed in each suburban district of London, and varied from 0.8 to 29.5 per cent. with an average of 4.4 per cent. This would clearly show that the number of traps examined in each district was far too small to give even a fair approximation to the correct average for the whole district, and yet the Committee had not hesitated to assume that they were dealing with correct averages, and had even

extended their unreliable percentages for London to the whole country by stating on page 8 that in modern intercepting traps over twenty-three per cent. or nearly one in every four was likely to prove unsatisfactory.

For this assertion they had produced no proof worth any consideration, and he would show later on they were absolutely wrong in extending their arbitrary and slipshod figures for London to the whole country.

He would make the further point that the results obtained in the various London districts were of so unequal a value or weight that they could not possibly be compared with each other, much less lumped together in one total. It stood to reason that a result obtained by counting only 0.8 per cent. of the total traps assumed to be in existence could not have the same value or weight as the result obtained by counting 29.5 per cent. of the assumedly existing total traps. He was at a loss to understand what justification the Committee had for giving their figures at all.

The Committee had also not attempted to give them any information as to the causes of the observed blockages, whether it was the trap itself, a badly laid drain, an inefficient discharge of the waste or flushing water, or bad usage, and no such information could be given as to previous blockages. And yet, without complete particulars they could not form a fair or correct opinion of the value or otherwise of the trap itself and its construction.

For instance, it had been given in the evidence that at Croydon (see page 102) 33.8 per cent. of the drains tested were found faulty, at Gloucester (see page 143) 23.4 per cent., at Leeds (see report, page 37) 27.30 per cent., and at St. Helens (see page 138) 21.4 per cent., or out of a total of 7222 examined (house to house inspection) 1798 faulty drains were discovered, which gave an average of 24.89 per cent. or say approximately twenty-five per cent. This was the result in provincial towns, and he believed that in the London districts mentioned in the report the percentage of faulty drains was probably much greater. The result of the provincial trap examinations, which he would mention later, forced this view upon him.

Again, for Newport in Wales, the Borough Surveyor had stated (see evidence, page 160) that out of 770 choked drains, only 212 or 27.53 per cent. were found obstructed in the disconnecting trap. It stood to reason that a badly laid drain might ultimately lead to the blocking of the disconnecting trap without any fault of its own, and the Newport figures showed that the choking of the drain was far more frequently caused by a badly laid drain itself, 72.47 per cent., than by the disconnecting trap, 27.53 per cent., the proportion being about three to one.

As to bad usage of the house drainage, everybody knew that the blockage of the disconnecting trap was often caused by solid substances having been thrown down the drain frequently through the w.c. trap. The evidence tendered before the Committee contained ample testimony to this, and without making any selection, he might, amongst others, refer to the evidence of Mr. Isaac Young on page 167, then the

chief sanitary inspector of Battersea, and to that of Mr. J. Patten-Barber on page 181, then borough engineer of Islington. Particularly interesting in this respect was the evidence of Prof. F. W. Andrewes on page 65. He spoke of the drainage of St. Bartholomew's Hospital, which was, as they might safely assume, well looked after and in which the sanitary appliances were used by a specially trained staff. He expressed the view that the blockages of the disconnecting traps were chiefly due to foreign substances getting into them (brushes, tooth-brushes, flowers, etc.). He, the author, had known a case, where the cook in a large house desiring always to eat new bread had thrown a lot of dry crusts down the drain, which had collected in the disconnecting trap and caused its complete blockage and an abominable stench.

Neither the report nor the evidence contained any particulars to speak of how the returns making up the table on page 50 of the report had been obtained. All they knew was that they were " eventually " obtained from twenty-one suburban districts of London with modern disconnecting traps, which he thought meant that the houses had been erected then comparatively recently. Why were the names of the districts or of the officials responsible for the returns purposely withheld ? Did the returns include impartially all the various districts of the particular town—good, indifferent and bad districts—or were they confined to one class only ? For Bournemouth, Mr. W. G. Cooper had supplied this information, and why could the same not have been done in the case of London ?

He was further of opinion, that some of the returns, which clearly indicated that not average, but specially faulty conditions predominated, should have been weeded out so as not to deteriorate the others. Take, for instance, District No. 21 with a population of 289,000. For that district only 302 traps had in all been examined, which was about 1.1 per cent. of all the assumedly existing traps. Here 53.6 per cent. of the traps examined for the second condition had been found faulty, and as this was far in excess of all the other returns it was quite clear, that special conditions existed here, which were not found in the others and could not be used for a general purpose. And yet the Committee had included this figure in the general average, which they had applied not only to London but to the whole country.

But what seemed to him the worst feature of that part of the report dealing with the physical or engineering features of the disconnecting trap was that the Committee had taken their totally inconclusive London results as applying to the country generally without mentioning with one word in their report the results of the provincial examinations of the trap which were at their disposal and published by them in the evidence. There was, apparently, no excuse for this silence, and the students of the report were bound to form their own conclusions !

He had abstracted from the evidence the returns for Blackpool (evidence, page 113), Bournemouth (evidence, page 82), Burton-on-Trent (evidence, page 50), Leicester (evidence, page 189), and Sunderland (evidence, page 178). In these towns with a total population of over half a million

in 1911, 4082 traps had been examined, which was—making the same assumption as for London—7.2 per cent. of all the traps in existence, a figure nearly twice as large as the corresponding figure for the London districts. In Bournemouth 1058 traps had been examined, a figure which was only once exceeded in the twenty-one London districts, and the figures for Leicester 1277, and for Sunderland 1218, had never been reached in these returns. This showed that the five provincial towns had gone to greater trouble in this respect than the twenty-one London districts and that their averages were more reliable than the London ones.

Taking first the first condition for which the traps had been examined, viz.: blockage at inspection, the percentages given were: for Blackpool, 8 per cent.; for Bournemouth, 1.61 per cent.: for Burton-on-Trent, 4.90 per cent.; for Leicester, 1.88 per cent.; and for Sunderland, 3.29 per cent.; on an average of these towns 2.69 per cent.

Taking next the second condition of previous blockage, the figures were: for Blackpool, 11 per cent.; for Bournemouth, 0.75 per cent.; no figures were given for Burton-on-Trent; for Leicester, 2.51 per cent.; for Sunderland, 1.23 per cent.; or on an average of these towns, making allowance for an incomplete return, 1.81 per cent.

Combining the two conditions, the figures were: for Blackpool, 19.00 per cent.; for Bournemouth, 2.36 per cent.; no figures were available for Burton-on-Trent; for Leicester, 4.39 per cent.; for Sunderland, 4.52 per cent.; or on an average of these towns, making again allowance for an incomplete return, 4.24 per cent.

Comparing these figures with the London ones, and taking for the two conditions combined, both the report figure of 23.49 per cent. and his own of 11.38 per cent., it would be seen that the faulty traps for the first condition were over two and a half times more numerous in London than in the provincial towns, for the second conditions over nine times more numerous, and for the two conditions combined, nearly six times or nearly three times more numerous, according to whether the report or his own figure was taken.

This was an astonishing result, and the question arose, What was the cause of this great difference between provincial towns and London?

Assuming that this difference could not be due to the forms of the traps used, as these were probably pretty much the same in London as in the provincial towns, it could only be due to the greater care and better supervision in the provincial towns in setting the trap and in laying the drains than in the London districts mentioned in the report, and probably also to more careful usage of the house drainage system, more efficient water supply for flushing purposes and more frequent inspection.

It was well known that a great deal of so-called jerry building had been going on in London in the past and he could not help thinking that the difference was largely due to this and that the London districts of the report contained a great number of jerry built houses.

If this were correct, and he thought it was, the figures given in the

report had no general application, not even for London, their application being strictly limited to the jerry class London property.

This was supported by the figures given on page 169 of the evidence for Battersea, which were even slightly better than those given for provincial towns. In this district there were only 1.9 per cent. of blocked traps, 1.3 per cent. of previously blocked traps, or 3.2 per cent. for the two conditions together, out of 1503 traps examined. It was only fair to mention this, as it should not go forth that conditions in London were bad all round.

It might be that the provincial figures were open to the same strictures as the London ones, but even if they were, he thought they were strictly comparable with them.

Summarising shortly his observations on that part of the Departmental Committee's report, which dealt with the physical or engineering features of the disconnecting trap, he would state as follows :

1. The table on page 50 of the report could not command their confidence. The names of the London districts were not given, it was not stated who was responsible for the collection of figures, whether special areas had been selected—good, indifferent or bad—or whether a careful selection of all areas had been made. Practically beyond the bare figures they had no information.

2. No attempt whatever had been made by the Committee to distinguish the various causes leading up to the blockage of the traps, whether this was due to the trap itself, a badly laid drain, an inefficient or insufficient discharge of waste water for flushing, or bad usage. And yet, without this very important information, it was totally wrong to lay the blame for all the blockages on the trap itself, as the Committee had not hesitated to do.

Further, they had included in their returns traps previously blocked quite indifferent to the fact that they had no chance whatever in this case to assign the true cause of blockage.

3. The Committee had apparently had no scruples to accept the figures given for each London district as a correct average for it. This was entirely wrong and contrary to the rules observed in all careful statistical inquiries. The figures only applied to a particular count and were far too small to be considered even a near approximation to the correct average for the whole of the district in question; some were so small that they were nothing more than a wild guess at this average.

4. The figures obtained in the various districts were of such unequal value or weight, that they were not comparable with each other and could not be lumped together without making the total a ridiculous figure. In a statistical inquiry of this kind it was against all recognised practice to link an observation of greater value with one of a lesser, as the latter was bound to invalidate the former. Yet, the Committee had not hesitated to do so and lay down the law from the result.

5. Some of the returns ought never to have been included, as on the face of them they clearly showed, that the enumeration must have been made in a particularly bad district not applicable for average purposes.

These the Committee should have weeded out, so as at any rate to preserve some appearance of critical scrutiny.

6. The report contained what he had called a serious mathematical miscalculation, but if he were wrong in this contention its language was so ambiguous and so little precise as to mislead, and this in an important report made at the public expense, was, if anything, worse than a miscalculation.

7. The worst feature of the report was its complete silence on the results obtained in the provincial towns, for which they had the figures in the evidence. What was the cause of this silence, especially in view of the fact that the provincial returns were evidently prepared with more care and showed much better results than the London returns ?

8. All this clearly showed, that the London figures could not be taken with confidence. They did not represent correct averages even for their respective largely jerry built districts. They did not apply to London generally, and to apply them to the country generally, was utterly wrong.

9. He had come to the conclusion that this part of the report dealing with " the most important " disadvantage of the trap must go for good and all and deserved no further consideration, it being utterly worthless !

And with it must go such observations that the liability of the trap to become blocked was insuperable and that such blockage was inherent in any disconnecting trap (see page 44 of the report).

When they came to consider the provincial returns and also the Battersea return, they must admit that the disconnecting trap had done its work remarkably well and deserved priase and not condemnation. For, if out of every 100 provincial traps less than three had been found blocked (two at Battersea) and less than two had shown signs of previous blockage (the same at Battersea), it was quite clear that the apparatus was a remarkably good one considering the little attention it received.

This further proved that the advocates of the disconnecting trap, who had maintained that they had experienced little or no difficulty with it were supported by the provincial and Battersea figures, and all the hubbub, which had been raised in some parts of London, was evidently due to the carelessness of the jerry builder, which had not been stopped by the authorities.

With these results before them, he thought the Ministry of Health deserved special thanks for not having adopted what must now be considered as the erroneous conclusions of some of its officials.

Where they still experienced difficulties with the trap in the jerry built portions of London, he thought the Willesden experience supplied the proper remedy. Here, by careful periodical inspections they had eventually succeeded in reducing the trap failures to quite insignificant proportions, i.e., from 17.8 per cent. in January, 1906, to 3.8 per cent. in 1910.

He would only add one or two further observations.

He was afraid his reference to the assumed total number of traps existing in England and Wales (see page 25 of his paper) had been completely misunderstood.

The Departmental Committee had not hesitated to apply the so-called London failures of the trap to the country generally by stating on page 8 of the report that one trap out of nearly every four modern disconnecting traps was likely to be faulty. This was, in his opinion, utterly wrong, and he wanted to show the absurdity of such a proceeding by pointing out that even if the London figures could be relied on, they were far too small to allow of their application to the whole country. He had stated so in his paper.

It had also been stated by one speaker, that local circumstances constituted the dominating factor of the application of the trap, that in fact in some parts of a town it might be enforced and in others forbidden, that every district had particular features, which must be considered. Such a hit-and-miss practice was, in his opinion, totally wrong, and would lead to endless difficulties in practice. He thought every house-owner should have the right to put up a disconnecting trap, if he thought well. Then, again, a district might be free from sewer gas to-day and full of it to-morrow, as conditions were perpetually changing in a large sewerage system, and they had little control over them. Further, what would the liability of the authority, if illness were caused in a district, in which they had forbidden the disconnecting trap, would they then be liable to compensation? He had mentioned a compensation case in his paper on page 21. And finally would they have to compel the owners to put up disconnecting traps after an outbreak of illness had occurred? That would be very much like locking the stable door after the horse had been stolen.

In conclusion, he would have preferred to remain silent on the failure of the report, as it was an unpleasant task to have to condemn an official statement or report, but he had been challenged in the discussion that his observations, made generally, were not fair, so that he really had no option in the matter. He hoped he had shown that his observations were based on solid fact and were perfectly justified, that there was absolutely no reason to scrap the trap and that such an action was equivalent to a compromise with carelessness and inefficiency at the serious risk of injury to health.

The problem set sanitary engineers by preventive medicine or hygiene was still before them, and so long as it remained the solution in the disconnecting trap must also remain.

At a time, when they were endeavouring to improve the health of the race by such means as medical inspection in schools, meals for children, dental clinics, health education, welfare institutions, National Health Insurance, health weeks, etc., etc., it would be to say the least, very foolish to take a step deliberately, which might endanger the health of the community.

He had no axe to grind, and all he cared for and begged his opponents to consider, was the health of the individual and the community, which should come first and foremost.

Mens sana in corpore sano.